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DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

BOVINE INFECTIOUS ABORTION
OR
BANG'S DISEASE OF CATTLE

Chas. A. MITCHELL, B.V.Sc.

ANIMAL DISEASES RESEARCH INSTITUTE
Hull, Quebec

Pathological Division
Health of Animals Branch

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PREFACE

Bovine Infectious Abortion or Bang's Disease of Cattle causes heavy financial loss to the live stock and dairy industries and is a serious factor in public health problems.

Long continued research and experiments, and the practical application of the knowledge gained, have clearly shown that by certain ways and means the disease can be successfully controlled and eliminated, and a herd of cattle built up and maintained free from infection.

This bulletin aims to give cattle owners the information and facts necessary for intelligently undertaking the elimination of this infection from their herds. As far as possible, technical terms, scientific details and explanations have been avoided and the essential information presented and emphasized so as to be most easily understood and put to practical use.

Continuous research on Bovine Infectious Abortion is carried on at the Animal Diseases Research Institute, whose function it is to advise, help and co-operate in problems of disease control and prevention.

E. A. WATSON,
Chief Pathologist.

BOVINE INFECTIOUS ABORTION

or BANG'S DISEASE OF CATTLE

INTRODUCTION

Abortions in cattle may be caused by various agencies which produce their effects in various ways. Among these are micro-organisms or germs and several different germs are capable, if colonized in the uterus, of causing abortion. The micro-organism, however, that causes by far the greatest number of abortions and that also has a special predilection for colonizing during pregnancy in the uterine cavity is known as *Brucella abortus* or Bang's bacillus. This micro-organism produces a definite infection in the animal and one that in the majority of instances lasts for years.

It is perhaps regrettable that the infection has been named bovine infectious abortion. This name seems to convey the meaning that abortion is always associated with infection and that the cessation of abortion indicates recovery. This is not true—the abortion is but an irregular symptom of infection—and it is perhaps an attempt to avoid this faulty nomenclature that some workers call the disease Bang's disease.

A few years ago cattle were thought to be the only susceptible animals. To-day we know that this was an erroneous view and that other lower animals are subject to infection. Nor is man immune since the causative microbe attacks him, producing a serious illness known as undulant fever and on this account bovine infectious abortion is no longer only of interest to rural and cattle-raising communities. The city and town dweller must give the problem a measure of attention because of the pathogenicity of the organism for man. Therefore, an account of the tremendous economic loss caused by this infection and also because of its relationship to the public health of our country it has undoubtedly become one of the foremost problems in the field of animal diseases.

While the infection may be one comparatively new to some sections of this country it is by no means new in the annals of comparative medicine. In England even as early as the sixteenth century or in the Elizabethan age the infectious nature of outbreaks of abortion was commented upon. During the period of the Napoleonic wars repeated reference may be found in the literature to abortions of an infectious character and the veterinarians of that period advised the isolation of the aborting animal and the burial of the expelled fetus. It was not until the year 1896, however, that the specific micro-organism was discovered. In the year mentioned Professor Bang of the University of Denmark isolated from an animal about to abort an organism which we to-day call the *Brucella abortus* and which is also frequently called Bang's bacillus (in honour of its discoverer). Not only did Bang isolate the organism but he studied its effects on animals and proved that it was capable of causing abortion.

Since that time an enormous amount of investigational work has been done and many remarkable observations have been made. As information has accumulated through the persistent work of research investigators the mistaken views formerly held have gradually given way to sound conceptions based upon experimental evidence. In the following pages an effort will be made to place in summarized and simplified form some of the outstanding points of interest.

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CAUSE OF THE INFECTION

The cause of the infection is a micro-organism or germ known as the *Brucella abortus* or Bang's bacillus. This is a small rod-shaped germ which multiplies only in the bodies of susceptible animals or on artificial culture media. It has no marked powers of resistance outside the animal body and is easily destroyed by drying heat and by the temperature of pasteurization.

WHERE THE MICRO-ORGANISM IS FOUND IN THE BODIES OF CATTLE

There are four definite locations of the *Br. abortus* in the bodies of infected cattle,—

(a) The Pregnant Uterus and Genital Tract.—The *Brucella abortus* is found in the pregnant uterus of many infected animals. After the expulsion of the fetus it rapidly disappears from the uterine cavity and usually in three or four weeks can no longer be found. This is an important point because it shows how useless are those treatments that aim at governing infection by the injection of various antiseptics into the genital tract.

(b) The Udder and Supramammary Lymph Glands.—In many cases the udder is the seat of a permanent infection. Once colonized in this organ it apparently lives from year to year and curiously enough without causing any marked visible damage to the udder tissue. The resistance of this tissue, however, to other infections, such as those caused by streptococci, seems to be lowered and as a result mastitis (inflammation of the udder) is frequently found in herds infected with the *Brucella abortus.*

The udder infection is undoubtedly one of the most important phases of the problem since from this gland may be constantly given off year after year micro-organisms. Remembering that not only cattle but men are susceptible to the *Brucella abortus,* the importance of udder infection is apparent and any control measures aimed at preventing the transference of live organisms from animal to animal or from animal to man must take into consideration udder infection and the consequent contamination of the milk from this gland.

(c) The Gastro-Intestinal Tract in Calves.—The *Brucella abortus* during embryonic life frequently makes its way to the uterus and subsequently into the amniotic fluid which surrounds the unborn calf. The calf from time to time swallows a portion of this fluid and in this way germs are taken into the gastro-intestinal tract.

The micro-organism may also reach the liver by way of the placenta (tissue which connects mother and fetus) and up the umbilical vein.

Calves from infected cows therefore frequently at time of birth (even in normal gestation periods) contain in their stomachs and intestines the *Br. abortus.* In the vast majority of these cases they are simply mechanical carriers of the germ *and permanent colonization has not taken place.* After birth the calf rapidly throws off the microbes and clears itself of infection.

This point must be thoroughly understood to appreciate the methods of control which aim at building from an infected herd a new generation of animals free from infection.

Another method by which the microbe gains entrance to the stomach and intestines of calves is by the feeding of milk drawn from cows with infected udders. Some believe that until the calf has passed the age when it is fed milk there is little danger of permanent colonization of the micro-organism taking place. Others do not agree with this view. It must be pointed out, however, that micro-organisms whether they colonize permanently in the calf or not pass through its alimentary tract alive and the excreta from such calves is therefore always a source of potential danger to other animals.

(d) The Genital Tract of Bulls.—In a number of cases the genital tract or the sexual glands of bulls are infected and it is quite noteworthy that animals so infected frequently break down and become sterile.

It is generally believed that infection in the bull is not very readily transmitted to cows but there can be no doubt that it is always a source of danger.

In addition to the four above-mentioned places of residence, the organism has been found in a few instances in certain lymphatic glands and in the spleen but there is no evidence to prove that the organism colonizes in these tissues with any regularity.

IN WHAT MANNER THE MICROBE LEAVES THE BODY

Since the udder and uterus have been shown as the principal storehouses of infection, from these organs must be given off the great bulk of germs for the spread of infection to susceptible animals. It must be remembered that the organism is found in the uterus only during pregnancy and for a few weeks following delivery. Therefore it makes its escape from the uterine cavity during a relatively short period of time. It is very important to keep this in mind since to control infection in a herd susceptible animals must not come in contact with the uterine fluids or tissues near the time of delivery.

The organism also makes its escape through the medium of the milk and this is undoubtedly one of the most important means whereby infection is passed from animal to animal or from animal to man. Unlike the uterus, the udder gives off organisms in many cases almost constantly from year to year and it is at once apparent that this continuous source of micro-organisms must be controlled if one is to control the spread of infection.

HOW MICROBES ARE PASSED FROM ANIMAL TO ANIMAL

If we keep in mind those fluids and tissues of infected animals known to frequently contain micro-organisms we may deduce how the *Brucella abortus* is transferred from one animal to another. Thus the milk, the afterbirth, and uterine fluids if brought by direct or indirect contact to susceptible animals may be the means of transferring infection.

For many years the bull was considered of the utmost importance in transferring infection. Experimental evidence does not substantiate this view and while considering an infected bull a potential source of danger we are not justified in believing that by sexual intercourse he transfers infection from himself to another animal.

CHANNELS THROUGH WHICH ORGANISMS ENTER BODY

At one time it was thought bovine infectious abortion was a venereal disease. As has been intimated, experiments have not substantiated this theory.

The majority of infections under ordinary farm conditions are thought to find entrance by way of the mouth—animals taking into their digestive tract contaminated food. Experimentally it has been found that infection may be transferred to a susceptible animal by the germ coming in contact with the mucous membrane of the eye or by entering the teat ducts.

SYMPTOMS OF INFECTION

Practically the only symptom of infection is the act of abortion and this is a very inconstant one since many animals that are infected never abort. Abortion (when it occurs) usually takes place only once or twice in the same animal although the infection in the majority of cases persists for life.

Thus we see that the act of abortion may indicate infection by the *Brucella abortus* but the absence of abortion does not indicate the absence of infection.

SEROLOGICAL EXAMINATIONS

The colonization of micro-organisms in the body of an animal causes that animal to produce in its blood certain defence substances, two of which are of interest to the reader—(*a*) Agglutinins, (*b*) Complement-Fixing Bodies. These substances are specific; that is, only the *Brucella abortus* can produce *Brucella abortus* agglutinins or *Brucella abortus* complement fixing substances. The presence of these two substances and their specific characters, also the fact that delicate tests have been worked out for their identification, makes it possible for the laboratory worker to diagnose infection. Two methods for detecting agglutinins are in use—one known as the rapid agglutination test and the other as the slow agglutination test. Each of these tests has its advantage and disadvantage and sometimes one test will discover agglutinins when the other method fails.

The complement-fixation test is a very intricate laboratory procedure and should only be carried out by thoroughly trained and competent serologists. It is unnecessary to describe the test, but reference to illustration No. 2 will show how clear cut are the reactions.

As might be expected, all animals do not react in exactly the same way to an invading organism and it therefore happens that a small percentage of infected animals fail to produce one or both of the two defence substances. Fortunately one of these substances is in nearly every instance produced. In our laboratories the two agglutination tests are employed and when possible the complement fixation test is also used. These tests make it possible to diagnose infectious abortion in the absence of clinical symptoms. Accordingly, they are of the utmost importance in the control of infection.

THE CHRONIC CARRIER

From what has already been said it is apparent that many animals are infected that never abort, also many animals are infected that abort but once or twice. These animals constantly carry in their bodies the *Br. abortus* from year to year without showing evidence of disease and give off these micro-organisms which are transferred to susceptible animals. These carriers act as constant reservoirs of the *Br. abortus*. It is therefore apparent that the diagnosis of infection in these is of paramount importance since until they are removed from the herd there is no opportunity for the elimination of infection.

Again these chronic carriers are bought and introduced into herds where infection is not present and the *Br. abortus* is therefore seeded throughout the country. The serological test made it possible to discover these chronic carriers.

The question is frequently asked, "Do many infected animals recover?". A study of a large group of animals over a considerable number of years demonstrated that only about three per cent of infected adult cattle permanently recover. There is a group, however, whose reactions fluctuate somewhat and if these are tested during their negative phase one may be misled into believing that the animal has recovered.

WHY INFECTION SHOULD BE ELIMINATED

Infectious abortion undoubtedly causes an enormous economic loss every year. This loss is caused in several ways. There is, of course, the loss of a percentage of calves but the loss in milk yield is of far greater importance from an economic standpoint. Infected animals are more susceptible to metritis (inflammation of the uterus), mastitis (inflammation of the udder) and to sterility. The combination of all these factors makes the economic loss from infectious abortion very great.

REMEDIES AND BIOLOGIC AGENTS

In chronic diseases such as tuberculosis and infectious abortion medicinal remedies have been of little value but this has not saved the live stock owner of this and other countries whose herds are infected from being exploited by

remedy makers. In fact infectious abortion has been an especially fertile field for this exploitation. As has been previously pointed out, an infected animal usually aborts but once or twice during her life. With this in mind one may understand how easily a remedy for infectious abortion may build a reputation. It cannot be too definitely stated that no drug or combination of drugs known to science to-day are of use in either preventing the animal from aborting or throwing off the infection. Money spent on remedies of this kind is simply wasted.

In regard to the use of biologic products, experiments have shown that the injections of what is known as the dead vaccine has no favourable effects. With regard to the living vaccine there is some difference of opinion since some of the investigators have found that the use of this product reduces the number of abortions.

It is important to know the nature of the live vaccine and the reason for its use.

The live vaccine is the *Br. abortus* suspended in a weak salt solution. The germs are alive and therefore if possessed of pathogenicity are capable of infecting a susceptible animal.

As has been pointed out, those animals that abort do so once or twice. Evidently the infected animal soon produces sufficient immunity to protect the placental membranes and thereby the life of the unborn calf.

It was believed that the injection into an animal of the living germ several months before conception would give her placental membranes the same protection that the natural disease may give. The animal is therefore infected with the live culture several weeks before the commencement of pregnancy. Many of these so-called vaccinated animals become chronic carriers of infection. It is, therefore, clear that the live vaccines do not control infection but in reality extend and perpetuate it. All that can be expected from this product is that to some extent the number of abortions may be reduced.

In view of the fact that infection is perpetuated and spread and that man is susceptible to the organisms, the live vaccine must be looked upon as a dangerous product.

THE CONTROL AND ELIMINATION OF INFECTIOUS ABORTION

Since medicinal agents are useless and vaccines are useless or dangerous, it is apparent that the elimination of this disease can only be attempted by sanitary methods and schemes of control. Fortunately there are several ways and means that make it possible to eliminate and control it. First—the serological tests. By these tests the infected animals may be discovered. Secondly calves born from infected animals if brought up in a suitable environment in the majority of instances are free from infection. Around these two points are built the schemes of control.

SCHEMES OF CONTROL

Single Unit Plan

This plan can be used only when the amount of infection in the herd is limited or the herd is small. By this plan the reacting or infected animals are discovered with the serological tests and they are at once removed from the herd and slaughtered. It is, of course, impossible economically to use this plan where infection is extensive and the financial losses therefore great.

Double Unit Plan

Those having stabling accommodation can eliminate infectious abortion from the herd without economic loss by the use of the double unit plan. The serological tests are applied and infected animals discovered. They are removed to separate quarters and are treated as a separate distinct herd. This herd is usually known as the positive reacting or infected herd. *Animals brought into this herd*

are not tested after they enter it. Occasionally an infected animal may give a temporary negative reaction but after a few weeks or months it usually returns positive.

Since calves from the positive reacting herd in the majority of instances are not permanently infected, they are segregated and fed upon milk from negative reacting animals for approximately ninety days and then tested and if they fail to react are introduced into the negative herd.

This plan of control has many advantages. It preserves the blood lines and the economic loss is negligible. Its chief disadvantage is that it requires stabling accommodation for two distinct herds. This, of course, many live stock men have not at their command.

RECOMMENDATIONS FOR THE ELIMINATION OF BOVINE INFECTIOUS ABORTION AND BUILDING UP A CLEAN HERD BY THE DOUBLE UNIT PLAN

1. That two distinct herds be established, one for reacting, the other for non-reacting animals; these herds to be kept separate from each other and no contact permitted.
2. That milk from infected animals be considered a source of danger and not be brought directly or indirectly in contact with the non-infected herd.
3. That afterbirths and aborted calves in the infected herd be burned or buried.
4. That calves from infected cows be removed as soon as possible after birth to neutral ground and there held for ninety days. During this period every sanitary precaution should be taken for their protection and only pasteurized milk or milk from non-reactors fed, also excreta should be cleaned away daily and stalls disinfected frequently. At the end of ninety days they should be tested and the negative ones removed, to the healthy herd. (*This is one of the most important steps in building up a healthy herd from infected animals. Every effort should be made to carry it out in a proper manner.*)
5. That the non-infected herd be retested at intervals of six weeks for two tests and then every three months until it has passed four clean tests (subsequently a yearly test suffices).
6. That all additions to non-infected herds should be tested before being introduced.

NOTE.—Calves occasionally react soon after birth but lose their reactions later. Those calves giving a positive reaction when ninety days old should be held as questionable animals for several months to definitely establish whether they are infected.

WHAT SHOULD BE DONE WITH THE REACTING ANIMAL

The reacting animal is an exceedingly dangerous animal especially if introduced into a herd where infection is not present. Those reacting animals discovered by the test should therefore not find their way into a non-infected herd. As an illustration it may be pointed out that in the past the serological tests have been applied, reactors discovered and the owner has subsequently sold these reactors to unsuspecting live stock men. Since clinical symptoms were absent, the buyer has no means of knowing that these animals were infected (unless he bought them subject to a serological test).

Because of this the department will conduct tests only under certain conditions. Information thereto may be had by applying to the Veterinary Director General, Health of Animals Branch, Department of Agriculture, Confederation Building, Ottawa, Ont.

THIRTY-TWO QUESTIONS AND ANSWERS REGARDING BOVINE INFECTIOUS ABORTION

1. What is Bovine Infectious Abortion?
   Bovine Infectious Abortion is an infection caused by the *Brucella abortus* (Bang's bacillus).

2. Is the *Brucella abortus* the only cause of abortion in cattle?
   No. Abortions are caused by other organisms and conditions but they are relatively few in comparison to those caused by the *Brucella abortus*.

3. Are there factors of economic importance other than that caused by the loss of the calf?
   Yes. There is frequently a reduced milk yield. Retained afterbirths, sterility or mammitis often accompany the infection. These collectively are economically of much more importance than the loss caused by abortion.

4. How is the infection introduced into the herd?
   By adding to the herd an infected animal, usually a female. This animal may never have aborted and no clinical symptom of illness indicates the presence of infection.

5. How are the germs spread to other animals?
   Many infected cows give off the organisms continuously in their milk and when this milk comes by direct or indirect means in contact with other animals, infection may be spread. Cows also distribute the germ in their uterine discharges and are particularly dangerous about the time they abort or calve. Some bulls give off the organisms from their genital tract and many indirectly infect other animals.

6. How do susceptible animals become infected?
   Usually by taking the *Brucella abortus* into their mouths with their food but any means whereby the organism gains access to the mouth, mucous membrane of the eye or the teat duct of a susceptible animal serves to transfer infection.

7. What are the two organs of the cow's body that act as the principal place of residence for the *Brucella abortus*?
   The udder and the pregnant uterus.

8. What sanitary precautions should be adopted with regard to these organs?
   The milk from infected animals should be looked upon as a continuous source of infection. Organisms are excreted from the uterus at the time of abortion and susceptible animals should be carefully guarded against the discharge from this organ. The dead fetus and afterbirths from infected animals should be burned or buried.

9. Do calves become infected?
   Calves usually are not permanently infected and because of this it is possible to build up a clean herd from an infected herd.

10. Do calves from reacting animals carry the *Brucella abortus* when they are born?
    Many calves from reacting animals contain in their stomachs and intestines the *Brucella abortus,* but in the majority of cases this is quickly thrown off and permanent colonization fails to take place.

11. Is the *Brucella abortus* dangerous to man?

Yes. Certain persons are susceptible to strains of the *Brucella abortus*. In man the symptoms may be mild or severe. In many cases it incapacitates the infected individual for months and recovery is exceedingly slow.

12. In what manner is the organism transferred to man?

It is believed that the organism is transferred to man by the drinking of raw milk or by infection through the broken skin carried by the medium of the milk or uterine discharges.

13. Does pasteurization of milk kill the organism?

Yes. Proper pasteurization kills the organism.

14. Do infected animals show clinical symptoms of disease?

As a rule, there is no clinical symptom with the exception of the act of abortion and this only occurs in a percentage of the infected individuals.

15. How may a diagnosis be made?

By conducting certain laboratory tests of the blood serum.

16. What tests do the Health of Animals Branch, Dominion Department of Agriculture, use?

The agglutination, and when possible, the complement-fixation test.

17. What reactions may be found in testing a herd of cattle?

(*a*) Positive reactions which indicate definite infection.

(*b*) Negative reactions which do not indicate infection.

(*c*) Questionable reactions. These reactions are neither definitely positive or negative but fall midway between. They are found in animals that have been in contact with organism but not permanently infected and they are also found in the early stages of infection.

18. What should be done with an animal giving a questionable reaction?

She should not be placed with the positive animals and should be kept separate, if possible, from those giving a negative reaction. She should be retested in approximately a month's time, at which time she will probably give a definite positive or negative reaction.

19. Are the serological tests reliable?

The serological tests, like all tests, have a margin of error but when applied and interpreted by trained serologists are wonderfully exact and reliable.

20. Do infected animals sometimes fail to react to the serological tests?

Yes. A small percentage of animals occasionally fail to react to the tests. This is more particularly true if the blood sample is drawn near the time of calving. A few animals also give rather inconstant reactions, giving a positive reaction one month, then becoming negative and again positive.

21. Do reacting animals recover from infection?

Yes. Reacting animals may recover, more especially those that have not reached breeding age, but only about three per cent of adult cattle recover.

22. What use may be made of the serological tests to control infection?

The infected animals and especially the chronic carriers may be discovered They may be separated from the non-infected animals and infection thereby controlled.

23. Is it necessary to slaughter infected animals in order to control infection?

No. If a man has stabling accommodation the reacting animals may be kept separate and the calves from these reacting animals may be used to build up the non-infected clean herd.

24. Are there medicinal agents for infectious abortion on the market and are they of use?

Yes. There are many medicinal agents sold which pretend to assist in the elimination of bovine infectious abortion. They are not effective and it is usually because animals abort only once or twice that these fake cures sometimes seem successful.

25. Are there vaccines prepared for the control of infectious abortion?

Yes, two vaccines are prepared: (1) the killed vaccine, (2) the living vaccine.

26. What is the killed vaccine and is it of use?

The killed vaccine is the *Brucella abortus* suspended in a salt solution and sufficient heat or antiseptics applied to destroy the life of the germ. It has not been found of use in the prevention, control or elimination of bovine infectious abortion.

27. What is the living vaccine or live culture?

It is the *Brucella abortus* organisms suspended in a solution of common salt.

28. Is this, therefore, not the live germ that causes bovine infectious abortion?

Yes.

29. Then how can it prevent the infection?

It does not prevent infection but may perpetuate it in a herd. Because an infected animal aborts usually once and then becomes tolerant to the germ, it was hoped by the introduction of the living culture, that what naturally took place during the course of infection might be artificially induced.

30. Does the organism introduced by vaccination ever colonize in the udder?

Yes, and it therefore may be distributed through the medium of milk to man and to susceptible cattle.

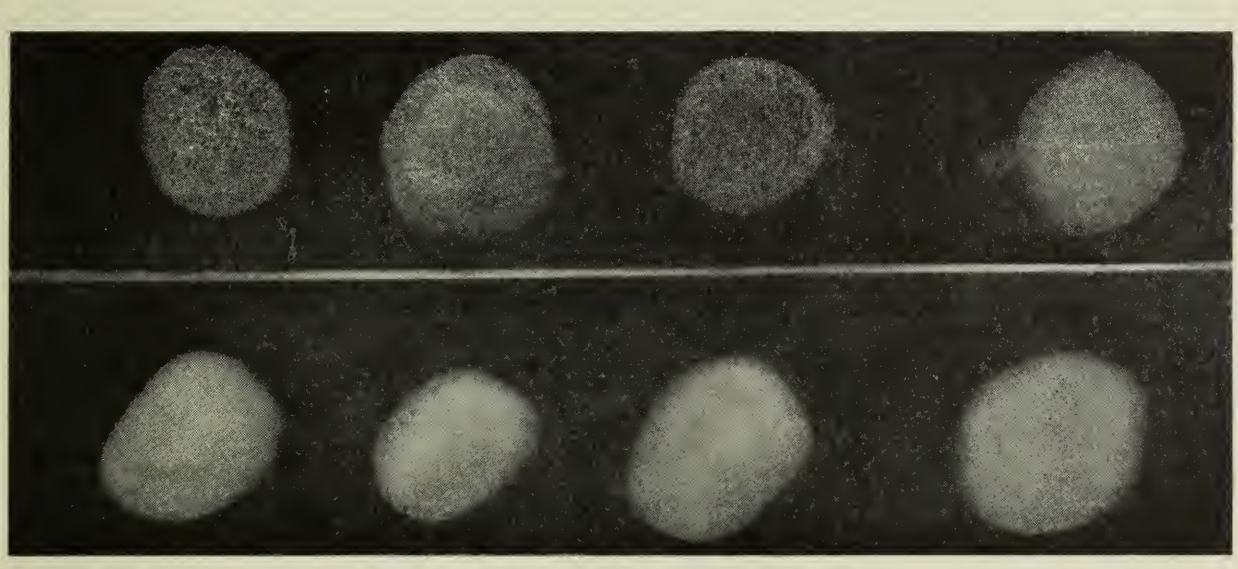
31. Is it possible to build up a non-infected herd by the use of the serological tests?

Yes, many are doing it to-day.

32. What is the first step to take?

If you believe you can carry out the agreement mentioned in this bulletin write the Veterinary Director General, Ottawa, for the necessary forms and information.

PLATE 1

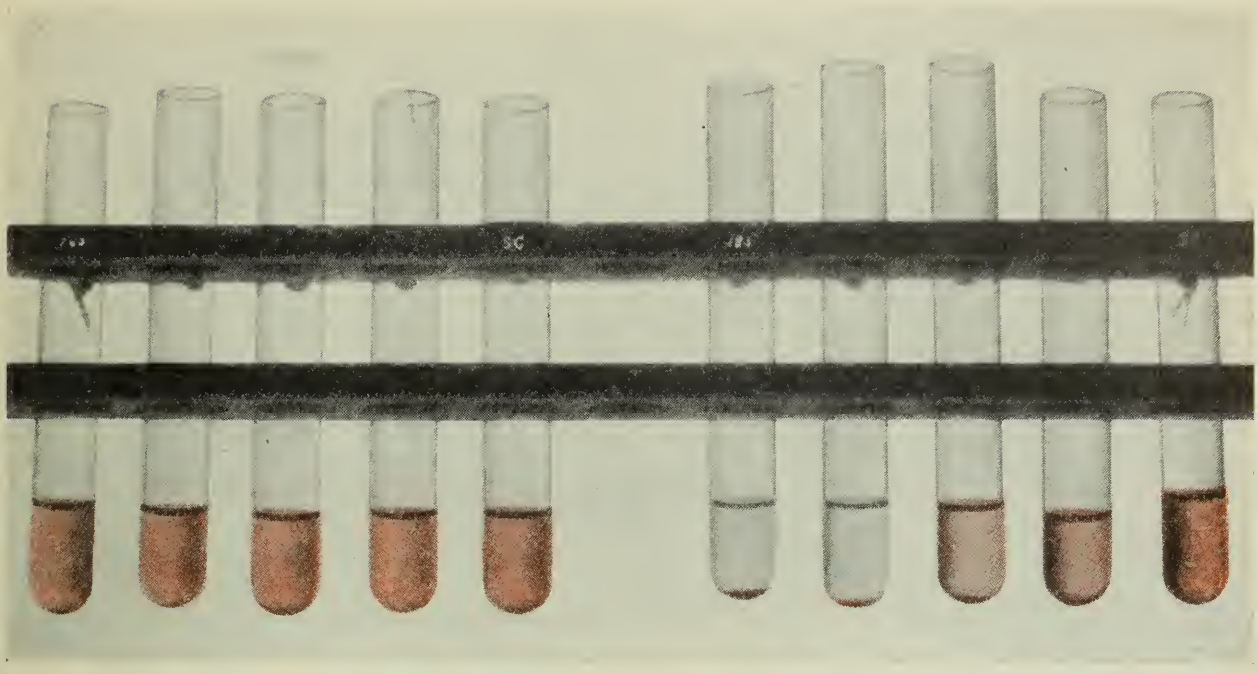


THE RAPID AGGLUTINATION TEST

Series of dilutions in the upper row where clumping occurs indicates the presence of agglutinins in the serum tested—positive reactions.

Series of dilutions in the lower row where clumping does not occur indicates the absence of agglutinins in the serum tested—negative reactions.

PLATE II

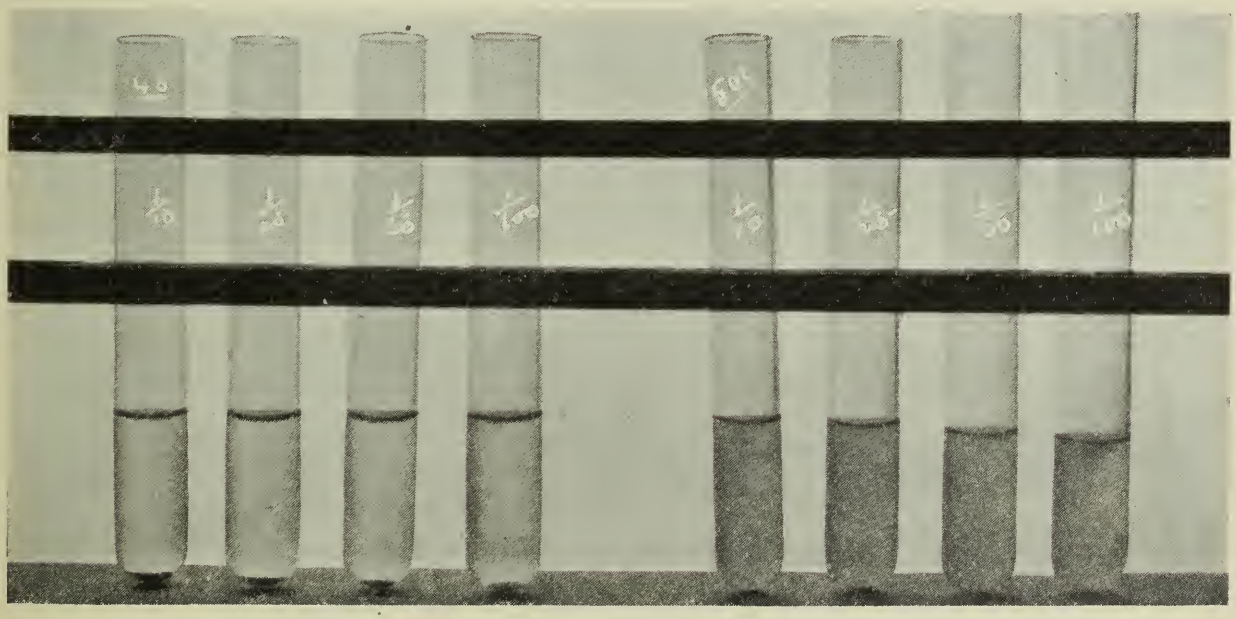


THE COMPLEMENT FIXATION TEST

Tubes uniformly red (negative reactions) indicate the absence of complement-fixing antibodies in the serum tested.

Tubes with red cells at bottom and clear liquid above (positive reactions) indicate the presence of complement-fixing antibodies in the serum tested.

PLATE III



THE SLOW AGGLUTINATION TEST

Series of tubes to the left, positive reaction. Note the clumped micro-organisms at bottom of tubes.

Series of tubes to the right, negative reaction. Note the uniform turbidity of the solution.

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